REMARKS

The Office Action dated November 30, 2007 has been received and carefully noted. The above amendments to the claims, and the following remarks, are submitted as a full and complete response thereto.

Claims 1-9, 13-14, and 18-19 have been amended to more particularly point out and distinctly claim the subject matter of the invention. Claim 16 has been previously cancelled. No new matter has been added. Therefore, claims 1-15, and 17-19 are currently pending in the application and are respectfully submitted for consideration.

The Office Action rejected claims 1-2, 5-10, and 13-19 under 35 U.S.C. §103(a) as being unpatentable over Coersmeier ("Frequency Selective IQ Phase and Amplitude Imbalance Adjustments for OFDM Direct Conversion Transmitters") in view of Yuda (U.S. Patent Pub. No. 2005/0018597). The Office Action took the position that Coersmeier discloses all of the elements of the claims, with the exception of N signal branches. The Office Action then cited Yuda as allegedly curing this deficiency in Coersmeier. The rejection is respectfully traversed for at least the following reasons.

Claim 1, upon which claims 2-5 are dependent, recites a system, which includes a generator configured to generate an original complex time domain IQ signal for N (N>1) signal branches, and N error correctors according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function. The system further includes N signal processing circuitries according to the N signal branches, each configured to

process the corrected complex time domain IQ signal of the respective signal branch, thereby obtaining a processed real signal of the respective signal branch, and a processing device. The processing device includes a receiver configured to receive an original complex time domain IQ signal of a signal branch of the N signal branches generated by the generator and a processed real signal of the signal branch, and a first calculator configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch. The processing device further includes a second calculator configured to calculate a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, and a third calculator configured to calculate control values of a correction function of the signal branch on the basis of the difference calculated by the second calculator. The processing device further includes a supplier configured to supply the control values calculated by the third calculator to the correction function of the signal branch. The receiver, the first to third calculators and the supplier are configured to repeat their operations for all N signal branches.

Claim 6, upon which claims 7-8 are dependent, recites an apparatus, which includes a receiver configured to receive an original complex time domain IQ signal of a signal branch of N (N>1) signal branches and to receive a processed real signal of the signal branch, and a first calculator configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original

complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch. The apparatus further includes a second calculator configured to calculate a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, and a third calculator configured to calculate control values of a correction function of the signal branch on the basis of the difference calculated by the second calculator. The apparatus further includes a supplier configured to supply the control values calculated by the third calculator to the correction function of the signal branch. The receiver, the first to third calculators and the supplier are configured to repeat their operations for all N signal branches.

Claim 9, upon which claims 10-13 are dependent, recites a method, which includes generating an original complex time domain IQ signal for N signal branches. The method further includes, in each of the N signal branches, performing error correction on the original complex time domain IQ signal by means of a correction function, and processing the corrected complex time domain IQ signal in a signal processing circuitry, thereby obtaining a processed real signal. The method further includes, in a processing device, receiving an original complex time domain IQ signal of a signal branch of the N signal branches generated and a processed real signal of the signal branch, and first calculating a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal

branch. The method further includes, in a processing device, second calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, and third calculating control values of a correction function of the signal branch on the basis of the difference calculated in the second calculating. The method further includes, in a processing device, supplying the control values calculated in the third calculating to the correction function of the signal branch, and repeating the steps performed in the processing device for all N signal branches.

Claim 14 recites a method, which includes first calculating a processed complex time domain IQ signal of a signal branch of N signal branches from a processed real signal and an original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch, and second calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal. The method further includes third calculating control values of a correction function of the signal branch on the basis of the difference calculated in the second calculating, and repeating the first to third calculating for all N signal branches.

Claim 15, which claim 17 is dependent, recites a computer program product, embodied on a computer-readable medium, which includes software code portions for controlling a computer to perform first calculating a processed complex time domain IQ signal of a signal branch of N signal branches from a processed real signal and an original complex time domain IQ signal of the signal branch using digital sample signs of the

original complex time domain IQ signal of the signal branch, and second calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal. The computer program product further includes software code portions for controlling a computer to perform third calculating control values of a correction function of the signal branch on the basis of the difference calculated in the second calculating, and repeating the first to third calculating for all N signal branches.

Claim 18 recites a system, which includes generating means for generating an original complex time domain IQ signal for N (N>1) signal branches, and N error correction means according to the N signal branches, each for performing error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function. The system further includes N signal processing means according to the N signal branches, each for processing the corrected complex time domain IQ signal of the respective signal branch, thereby obtaining a processed real signal of the respective signal branch, and a processing device. The processing device includes receiving means for receiving an original complex IQ time domain signal of a signal branch of the N signal branches generated by the generating means and a processed real signal of the signal branch, and first calculating means for calculating a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch. The processing

device further includes second calculating means for calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, and third calculating means for calculating control values of a correction function of the signal branch on the basis of the difference calculated by the second calculating means. The processing device further includes supplying means for supplying the control values calculated by the third calculating means to the correction function of the signal branch. The receiving means, the first to third calculating means and the supplying means repeat their operations for all N signal branches.

Claim 19 recites an apparatus, which includes receiving means for receiving an original complex time domain IQ signal of a signal branch of N signal branches and receiving a processed real signal of the signal branch, and first calculating means for calculating a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch. The apparatus further includes second calculating means for calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, and third calculating means for calculating control values of a correction function of the signal branch on the basis of the difference calculated by the second calculating means. The apparatus further includes supplying means for supplying the control values calculated by the third calculating means to the correction function of the signal branch. The receiving means, the first to third

calculating means and the supplying means to repeat their operations for all N signal branches.

Thus, according to embodiments of the present invention, a software-hardware approach is provided which reduces the amount of N different pre-equalizers to only a single pre-equalizer implementation for the overall multi-antenna transmitter.

As will be discussed below, the combination of Coersmeier and Yuda fails to disclose or suggest all of the elements of the claims, and therefore fails to provide the advantages and features discussed above.

Coersmeier discloses time domain adjustment techniques which employ a decision directed IQ amplitude and filter pre-equalizer. The non-decision aided IQ phase adjustment provides a pre-equalizer-like architecture and processes a certain amount of time domain coefficients. Coersmeier also discloses implementing the IQ error detection algorithms via software on a Digital-Signal-Processor (DSP) and the IQ error corrections via hardware in an ASIC or FPGA. As part of the non-decision aided IQ phase adjustment, Coersmeier discloses that the IQ estimation is provided by a digital base-band block which provides estimates of the virtual analog I- and Q-values at the antenna input port without a down-modulation process.

Yuda discloses a radio base-station apparatus. The apparatus includes a transmission weight computing section for computing a transmission weight for directional transmission using an OFDM signal, a transmission correcting value memory section for storing one correcting value for correcting the transmission weight for each

sub-carrier of an OFDM signal or each band gathering a plurality of sub-carriers, a transmission weight correcting section for correcting the transmission weight by the correcting value, and a transmitting branch for weighting transmission data with a transmission weight outputted from the transmission weight correcting section on a sub-carrier-by-sub-carrier basis and deliver it to an antenna element.

Applicants respectfully submit that Coersmeier and Yuda, whether considered alone or in combination, fail to disclose or suggest all of the elements of the present claims. For example, the combination of Coersmeier and Yuda does not disclose or suggest, "a first calculator configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch," as recited in claim 1 and similarly recited in claims 6, 9, 14, 15, 18 and 19. The combination of Coersmeier and Yuda also fails to disclose or suggest, "N error correctors according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function," as recited in claim 1 and similarly recited in claims 9, 18 and 19.

It is an object of the present invention to provide an improved error adjustment method and apparatus, by means of which the signal accuracy at a direct conversion architecture output can be improved to thereby reduce analog filter requirements in particular in a multi-antenna transmitter. According to embodiments of the invention,

therefore, a processed complex time domain IQ signal is calculated from a processed real signal and an original complex time domain IQ signal of a signal branch. This calculation is achieved using digital sample signs of the original complex time domain IQ signal of a signal branch (see Specification, paragraphs 0085, 0100-0103).

In rejecting claims 1, 6, 9, 14-15, and 18-19, the Office Action failed to cite any portion of Coersmeier for its assertion that Coersmeier discloses "using digital sample signs of the original complex time domain IQ signal of the signal branch." Instead, the Office Action merely stated that "[t]he original complex IQ signal corresponds to any of the four planes of the IQ constellation determined by the sign of the I and Q values." (see Office Action at page 3). Furthermore, in the "Response to Arguments" section, the Office Action again failed to cite any portion of Coersmeier to support its assertion that Coersmeier discloses "using digital sample signs of the original complex time domain IQ signal of the signal branch." Instead, the Office Action stated "the original complex IQ signal corresponds to any of the four planes of the IQ constellation which is determined by the sign of the I and Q values. Therefore, the signs of the I and Q values of the original complex signal are considered when calculating the processed complex time domain IQ signal in the first calculating unit." (see Office Action at page 9).

Applicants respectfully submit that, simply because Coersmeier discloses that the IQ Estimation block receives envelope measurement results and ideal IQ samples and calculates estimated IQ values, one of ordinary skill in the art could not necessarily conclude that the signs of the IQ samples are used to calculate the estimated IQ values. It

is possible that the signs of the envelope measurement results are used to calculate the estimated IQ values, or it is possible that neither set of signs are used. Coersmeier simply fails to disclose or suggest how (or if) the signs of the ideal IQ samples are used. Instead, Coersmeier merely discloses, with respect to Figure 1, that a digital base-band block provides estimates of the virtual analog I- and Q- values at the antenna input port without a down-modulation process. (see Coersmeier at page 33, column 1, second paragraph; Figure 1). Furthermore, Coersmeier merely discloses, with respect to Figure 4, that a Digital-Signal-Processor (DSP) performs the IQ sample estimation from the envelope, and that the DSP receives the envelope measurement result and ideal IQ samples through a data bus, and that the DSP uses a software-based algorithm which is stored in the instruction memory. (see Coersmeier at page 33, column 1, last paragraph; page 33, column 2, first full paragraph; Figure 4).

In contrast, embodiments of the present invention disclose that in calculating a processed complex IQ signal from a processed real signal and an original complex IQ signal, the digital sample signs of the processed complex IQ signal are used. Specifically, the specification discloses that, in embodiments of the present invention, in performing digital IQ estimation, <u>the digital sample signs of the original complex IQ signal are reused instead of the corresponding analog values</u>. In performing the estimation, s_I represents the digital sample size of the I-branch value of the original complex IQ signal, and s_I is used in conjunction with A_a, the discrete base-band equivalent of the imperfect transmitter output, to calculate the estimated I-branch value of

the processed complex IQ signal. Furthermore, in performing the estimation, s_Q represent the digital sample size of the Q-branch value of the original complex IQ signal, and s_Q is used in conjunction with A_a to calculate the estimated Q-branch value of the processed complex IQ signal. (see Specification at page 18). Thus, the specification discloses that, in embodiments of the invention, <u>the sample signs of the processed real signal are replaced with the digital sample signs of the original complex IQ signal</u>. Thus, the specification discloses that, in embodiments of the invention, <u>the digital sample signs of the original complex IQ signal, are used in the calculation, not the analog sample signs of the processed real signal</u>.

Furthermore, the Office Action appears to make an inherency argument that calculating a processed complex time domain IQ signal from a original complex IQ signal <u>inherently</u> includes using the sample signs of the original complex IQ signal to calculate the process complex time domain IQ signal. However, the Office Action has failed to provide objective evidence or cogent technical reasoning to support its apparent inherency conclusion. This is improper under U.S. patent law, and the MPEP. "In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic <u>necessarily</u> flows from the teachings of the applied prior art." *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990). Therefore, on this ground alone, the Office Action's rejection of claims 1, 6, 9, 14-15, and 18-19 is improper, and Applicants respectfully request that the rejection be withdrawn. In the alternative,

Applicants respectfully request a new non-Final Office Action (a) stating that the Office Action is relying upon an inherency theory, and explicitly providing the basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teaching of Coersmeier; or (b) stating that the Office Action is not relying upon an inherency theory, and explicitly providing the page and line number of Coersmeier or Yuda where "using digital sample signs of the original complex time domain IQ signal of the signal branch" is allegedly disclosed.

Thus, Coersmeier fails to disclose, or suggest "a first calculator configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch," as recited in claim 1 and similarly recited in claims 6, 9, 14, 15, 18 and 19.

With respect to "N error correctors according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function," as acknowledged by the Office Action, Coersmeier only discloses one branch of a direct conversion transmitter analog front-end. Thus, Coersmeier fails to disclose or suggest "N error correctors according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function," as recited in claim 1 and similarly recited in claims 9, 18 and 19.

With respect to Yuda, the Office Action failed to address Applicants' arguments as to why Yuda failed to cure these deficiencies in Coersmeier. As previously argued, Yuda discloses a correcting branch 121 for computing a correcting value. The correcting value is to detect a frequency characteristic of amplitude/phase deviation in the transmitting-signal circuit section 105 and to correct a deviation thereof. A frequency-response correcting value detecting section 114 is to detect a frequency characteristic of amplitude and phase deviation on a signal Sct4 from the correcting branch 121, on the basis of an output signal St2 of the weight operating section 102 in the transmitting branch 102. Thus, according to Yuda, correction is performed in frequency domain, where a weighted signal is taken for comparison with a transmitted signal in block 114, not on the basis of a complex time domain IQ signal. Thus, Yuda does not disclose estimation, and ultimately correction, which is performed on the basis of a complex time domain IQ signal. Nor does Yuda disclose calculating a processed complex time domain IQ signal of a signal branch from a processed real signal and an original complex time domain IQ signal branch, using digital sample signs of the original complex time domain IQ signal of the signal branch. Therefore, the combination of Coersmeier and Yuda does not disclose or suggest, at least, "a first calculator configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch," as recited in claim 1 and similarly recited in claims 6, 9, 14, 15, 18 and 19; and "N error correctors

according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function," as recited in claim 1 and similarly recited in claims 9, 18 and 19.

Claims 2, 5, 7, 8, 10, 13 and 17 are dependent upon claims 1, 6, 9, and 15, respectively. Accordingly, claims 2, 5, 7, 8, 10, 13 and 17 should be allowed for at least their dependence upon claims 1, 6, 9, and 15, and for the specific limitations recited therein.

Claims 3 and 11 were rejected under 35 U.S.C. §103(a) as being unpatentable over Coersmeier and Yuda, further in view of Heiskala (U.S. Patent No. 6,700,453). The rejection is respectfully traversed for at least the following reasons.

Coersmeier and Yuda are discussed above. Heiskala discloses a method and arrangement for compensating for amplitude imbalance of a quadrature modulator. The method includes determining a first correlation on the basis of a first modulation signal and an output signal of the quadrature modulator, determining a second correlation on the basis of a second modulation signal and the output signal of the quadrature modulator, producing a compensation signal proportional to the amplitude imbalance on the basis of a ratio of the determined correlations and the first and second modulation signals, and processing at least one of the modulation signals of the quadrature modulator with the compensation signal.

Claims 3 and 11 are dependent upon claims 1 and 9, respectively. As discussed above, Coersmeier and Yuda do not disclose or suggest all of the elements of claims 1

and 9. Furthermore, Heiskala does not cure the deficiencies in Coersmeier and Yuda, because Heiskala does not disclose that its method and arrangement for compensating for amplitude imbalance of a quadrature modulator uses digital sample signs of an original complex time domain IQ signal of a signal branch. Thus, Heiskala does not disclose or suggest, at least, "a first calculator configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch," as recited in claim 1, and similarly recited in claim 9. Thus, the combination of Coersmeier, Yuda and Heiskala does not disclose or suggest all of the elements of claims 3 and 11. Additionally, claims 3 and 11 should be allowed for at least their dependence upon claims 1 and 9, and for the specific limitations recited therein.

Claims 4 and 12 were rejected under 35 U.S.C. §103(a) as being unpatentable over Coersmeier, Yuda, and Heiskala, and further in view of Shirali (U.S. Patent No. 7,085,330). The rejection is respectfully traversed for at least the following reasons.

Coersmeier, Yuda, and Heiskala are discussed above. Shirali discloses a signal processing method and apparatus capable of correcting signal distortion introduced by an RF power amplifier. Shirali generally describes the use of a buffer to store a plurality of samples representing at least a portion of an input signal intended for amplification by the RF power amplifier, the use of a self-receiver to receive an output signal generated by the RF power amplifier, and the use of a synchronization unit to determine, as a matching

input sample, which of the stored plurality of samples corresponds most closely to the output signal. Shirali also generally describes and the use of a predistortion unit to selectively apply a distortion correction function to the input signal prior to amplification by the RF power amplifier in which the distortion correction function being derived from a relationship between the matching input sample and the output signal.

Claims 4 and 12 are dependent upon claims 1 and 9, respectively. As discussed above, Coersmeier, Yuda, and Heiskala do not disclose or suggest all of the elements of claims 1 and 9. Furthermore, Shirali does not cure the deficiencies in Coersmeier, Yuda and Heiskala, because Shirali does not disclose that its signal processing method and apparatus, which is capable of correcting signal distortion introduced by an RF power amplifier, uses digital sample signs of an original complex time domain IQ signal of a signal branch. Thus, Shirali does not disclose or suggest, at least, "a first calculator configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch using digital sample signs of the original complex time domain IQ signal of the signal branch," as recited in claim 1, and similarly recited in claim 9. Thus, the combination of Coersmeier, Yuda, Heiskala and Shirali does not disclose or suggest all of the elements of claims 4 and 12. Additionally, claims 4 and 12 should be allowed for at least their dependence upon claims 1 and 9, and for the specific limitations recited therein.

For at least the reasons discussed above, Applicants respectfully submit that the cited prior art fails to disclose or suggest all of the elements of the claimed invention. These distinctions are more than sufficient to render the claimed invention unanticipated and unobvious. It is therefore respectfully requested that all of claims 1-15 and 17-19 be allowed, and this application passed to issue.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the applicant's undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being timely filed, the applicant respectfully petitions for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 50-2222.

Respectfully submitted,

Majid S. AlBassam
Registration No. 54,749

Customer No. 32294
SQUIRE, SANDERS & DEMPSEY LLP
14TH Floor
8000 Towers Crescent Drive
Tysons Corner, Virginia 22182-2700
Telephone: 703-720-7800
Fax: 703-720-7802

KMM:ksh